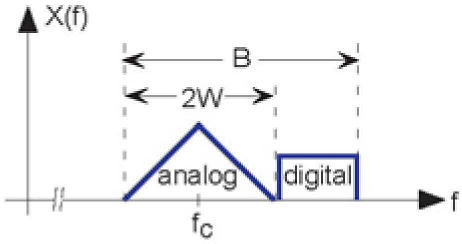

Figure 6.38

1. Write an expression for the time-domain version of the transmitted signal in terms of m(t) and the digital signal *d(t)*.
2. What is the maximum datarate the scheme can provide in terms of the available bandwidth?
3. Find a receiver that yields both the analog signal and the bit stream.

Problem 6.14: Digital Stereo

Just as with analog communication, it should be possible to send two signals simultaneously over a digital channel. Assume you have two CD-quality signals (each sampled at 44.1 kHz with 16 bits/sample). One suggested transmission scheme is to use a quadrature BPSK scheme. If $b^{(1)}(n)$ and $b^{(2)}(n)$ each represent a bit stream, the transmitted signal has the form

$$x(t) = A\sum_{n} \left(b^{(1)}(n)\sin(2\pi f_c(t-nT))p(t-nT) + b^{(2)}(n)\cos(2\pi f_c(t-nT))p(t-nT)\right)$$

where *p(t)* is a unit-amplitude pulse having duration *T* and $b^{(1)}(n)$, $b^{(2)}(n)$ equal either +1 or -1 according to the bit being transmitted for each signal. The channel adds white noise and attenuates the transmitted signal.

1. What value would you choose for the carrier frequency f_c?
2. What is the transmission bandwidth?
3. What receiver would you design that would yield both bit streams?

Problem 6.15: Digital and Analog Speech Communication

Suppose we transmit speech signals over comparable digital and analog channels. We want to compare the resulting quality of the received signals. Assume the transmitters use the same power, and the channels introduce the same attenuation and additive white noise. Assume the speech signal has a 4 kHz bandwidth and, in the digital case, is sampled at an 8 kHz rate with eight-bit A/D conversion. Assume simple binary source coding and a modulated BPSK transmission scheme.

1. What is the transmission bandwidth of the analog (AM) and digital schemes?
2. Assume the speech signal's amplitude has a magnitude less than one. What is maximum amplitude quantization error introduced by the A/D converter?
3. In the digital case, each bit in quantized speech sample is received in error with probability p_e that depends on signal-to-noise ratio

$$\frac{E_b}{N_0}.$$